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(54) FUEL CELL AND ITS OPERATING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To minimize the apparatus to be arranged around a cell and a device to simplify the structure by constituting a separator having a fuel gas passage and an oxidizer gas passage arranged therein so as to be usable also as a cooling plate.

SOLUTION: The fuel cell 7 of a solid polymer type fuel cell 1 comprises a solid polymer electrolytic film 2a conductive and air-permeable fuel electrode film 3 and oxidizer electrode film 4 arranged on both sides of the solid polymer electrolytic film 2a fuel gas separator 5 having a fuel gas passage for supplying a gas to the electrode film 4 and discharging the gas from the electrode film 4and

an oxidizer gas separator 6 having an oxidizer gas passage. Furthera heat pipe 9 having a radiation fin 11 is provided at the end of the oxidizer gas separator 6. In this casethe heat pipe 9 with the radiation fin 11 is connected to one side of the substantially rectangular oxidizer gas separator 6.

CLAIMS

[Claim(s)]

[Claim 1]A fuel electrode film (3) and an oxidant electrode film (4) which combine solid polyelectrolyte membrane (2)and conductivity arranged to both sides of this solid polyelectrolyte membrane (2) and breathabilitySupply gas to this fuel electrode film (3) and an oxidant electrode film (4)and Or an electrode layer (3)In a solid polymer type fuel cell (1) which laminates two or more fuel cell cells (7) which comprise a separator for oxidant gas (6) which has a separator for fuel gas (5) and an oxidant gas passage which have a fuel gas flow route for discharging gas from (4)and constitutes a layered productA fuel cell being the structure where said separator for fuel gas (5) and a separator for oxidant gas (6) have a heat pipe (9)and a fin for heat dissipation (11) was provided in this heat pipe (9).

[Claim 2]A separator for fuel gas (5) and a separator for oxidant gas (6) which have said heat pipe (9)The fuel cell according to claim 1 being the structure where have arranged a tube-like pipe in a metal plate which has conductivityand hydraulic fluid (10) which is a heat transporting medium was enclosed in this pipe.

[Claim 3]The fuel cell according to claim 1wherein said heat pipe (9) is a structure which a chilling effect will reveal if it reaches more than constant temperature by enclosing inactive gassuch as air and nitrogen gaswith an inside at containerssuch as bellows (12).

[Claim 4]Make a fuel cell (1) generate by supplying fuel gas and oxidant gasand at the time of starting of a fuel cell (1)according to adiabatic efficiency of a heat pipe (9)while carrying out a rise in heat promptly by a fuel cell cell's (7) own generation of heatAn operating method of the fuel cell according to claim 1 to 3

emitting into the atmosphere reaction fever which the cooling function of a heat pipe (9) operates and is generated with a cell reaction via a heat pipe (9) when it becomes beyond temperature with a fuel cell cell (7).

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to a fuel cell provided with the separator which comprises the cellular structure of the polymer electrolyte fuel cell which uses solid polyelectrolyte membrane as an electrolyteespecially a heat pipeand an operating method for the same.

[0002]

[Description of the Prior Art]The composition of the conventional fuel cell is shown in drawing 4. Polymer electrolyte fuel cell 1' supplies gas to the fuel electrode film 3 and the oxidant electrode film 4and pan which combine the solid polyelectrolyte membrane 2and the conductivity allotted to both sides of this solid polyelectrolyte membrane 2 and breathability at that electrode layerOr two or more fuel cell cells 7 which consist of the separator 6 for oxidant gas which has the separator 5 for fuel gas and oxidant gas passage which have a fuel gas flow route for discharging gas from an electrode layer are laminatedevery lamination number of sheets -- or the cold plate 8 which has a cooling-medium channel the fuel cell cell 7 and by turns is arranged and constituted.

[0003]In this fuel cell 1'in order to supply the oxidant gas which uses hydrogen as main fuelsuch as fuel gasairor oxygenrespectivelyto exhaust the reaction fever which generates heat when reacting electrochemically and to keep the temperature of the fuel cell cell 7 constantthe cold plate 8 is arranged.

[0004]The conventional fuel cell system figure is shown in drawing 5. In the figurethe pump by which 14 was connected to the fuel cell system and 17 was

connected to polymer electrolyte fuel cell 1'and 19 are the cooling systems similarly connected to fuel cell 1'and this cooling system 19 is connected to the water tank 20 via the cooling-circulating-water piping 18. 21 is a fuel part. In this fuel cell system 14water is mainly used as a cooling mediumThe cooling-medium channel was supplied by the power of the pump 17 gradeand keeping constant the temperature of the fuel cell cell 7 shown in drawing 4after it was cooled by the cooling system 19 for exclusive use or air cooling means etc. and the cooling medium used as the elevated temperature discharged from the cold plate 8 became low temperatureit was again supplied to the cold plate 8and it circulated through it.

[0005]Conventionallyin such fuel cell 1'management etc. of the water which is the pump power for circulating equipment of the pump 17 for cooling said fuel cell cell 7the cooling-circulating-water piping 18the cooling system 19 for exclusive useor an air cooling means and a cooling medium and a cooling medium needed to perform maintenance. The separator which is a component member of the fuel cell cell 7and the cold plate 8 were formed from the carbon which has conductivityand a manufacturing cost is expensiveand the cost of equipment of a cooling system etc. also required that including material and a conversion costand they had checked low cost-ization.

[0006]

[Problem to be solved by the invention]The pump for cooling a fuel cell cell in the conventional fuel cellcooling-circulating-water pipinga cooling system for exclusive useor an air cooling means needs to be furnishedAnd since the manufacturing cost of a fuel cell cell is expensivea miniaturization and weight saving of equipmentand low cost-ization have been preventedFor there to be a fault that the pump power for circulating a cooling medium is requiredand reduce the efficiency under power generation and management etc. of the water which is a cooling medium need to be maintenance workedto lessen the apparatus arranged around a fuel cell and equipment as much as possibleand to have easy composition is desired.

[0007]The place which it was proposed in order that this invention might solve an aforementioned problemand is made into the purposeEquipment of the pump for cooling a fuel cell cell by considering it as the separator with which the fuel gas flow route and the oxidant gas passage have been arrangedand the structure which served both as the cold platecooling-circulating-water pipinga cooling system for exclusive useor an air cooling means is unnecessaryThe pump power for circulating a cooling mediummanagement of the water which is a cooling medium furtheretc. are not neededbut the small size and the weight saving of equipmentand low cost-ization are attainedthe efficiency under power generation is raisedand maintenance control is easy and there is in providing a fuel cell obtained inexpensive and an operating method for the same.

[0008]

[Means for solving problem]To achieve the above objectsthe fuel electrode film 3 and the oxidant electrode film 4 which combine the conductivity by which this invention has been arranged to both sides of the solid polyelectrolyte membrane 2 and this solid polyelectrolyte membrane 2and breathabilityGas is supplied to this fuel electrode film 3 and the oxidant electrode film 4Or in the solid polymer type fuel cell 1 which laminates two or more fuel cell cells 7 which comprise the separator 6 for oxidant gas which has the separator 5 for fuel gas and oxidant gas passage which have a fuel gas flow route for discharging gas from the electrode layers 3 and 4and constitutes a layered productSaid separator 5 for fuel gas and the separator 6 for oxidant gas have the heat pipe 9and it is characterized by being the structure where the fin 11 for heat dissipation was formed in this heat pipe 9.

[0009]The separator 5 for fuel gas and the separator 6 for oxidant gas which have said heat pipe 9 arrange a tube-like pipe in the metal plate which has conductivityand are characterized by being the structure where the hydraulic fluid 10 which is a heat transporting medium was enclosed in this pipe.

[0010]By enclosing inactive gassuch as air and nitrogen gaswith the inside of a heat pipe at the container of bellows 12 gradeif the radiator of said heat pipe 9

reaches more than constant temperatureit will be characterized by being the structure which a chilling effect reveals.

[0011]As an operating method of the fuel cell of the above-mentioned compositionMake the fuel cell 1 generate by supplying fuel gas and oxidant gasand at the time of starting of the fuel cell 1according to the adiabatic efficiency of the heat pipe 9while carrying out a rise in heat promptly by generation of heat of fuel cell cell 7 selfWhen it becomes beyond temperature with the fuel cell cell 7the reaction fever which the cooling function of the heat pipe 9 operates and is generated with a cell reaction is emitted into the atmosphere via the heat pipe 9.

[0012]

[Mode for carrying out the invention]This invention transmits heat to two or more fins for heat dissipation via a heat pipeand exhausts in the atmosphere the reaction fever which generates heat when using a heat pipe for the separator of a fuel cell cell and reacting to it electrochemically in a fuel cellIt is characterized [main] by keeping uniform the temperature of the fuel cell which laminates two or more sheets and constitutes a layered product.

[0013]The separator with which it comes to match a Prior art a fuel gas flow route and an oxidant gas passageand the cold plate which has a cooling-medium channelInstead of the cooling system for exclusive use being arranged independentlyrespectivelythe separator with which the fuel gas flow route and the oxidizer passage were allotted comprises a heat pipeTwo or more fins for heat dissipation are formed in said heat pipeand the hydraulic fluid which is a heat transporting medium is enclosed in a metal plateand it is considered as integrated structureand differs in that it has a chilling effect.

[0014]By thusthe thing for which it serves both as the separator and cold plate with which the fuel gas flow route and the oxidant gas passage have been arranged in said fuel cell celland a fuel cell is constituted as integrated structure. It becomes possible to make simple the apparatus arranged around a fuel cell and equipment like the fuel cell system 14 by this invention shown in drawing

3As a resultin about 1/3 of equipmentand capacity and weighta manufacturing cost becomes conventionally reducible [1/2]and maintenance control becomes easyand the small size and the weight saving of equipmentand low cost-ization can be attained. By supplying fuel gas and oxidant gasthe operating method of this invention **** fuel cell makes a fuel cell generateand emits into the atmosphere the reaction fever generated with a cell reaction via a heat pipe. By enclosing inactive gassuch as air and nitrogen gaswith a heat pipe at containerssuch as bellowsand forming in the inside of a heat pipeAt the time of fuel cell startingit has adiabatic efficiencya fuel cell cell is heated promptlyshortening of warm-up time is aimed atwhen it reaches beyond temperature with fuel cell cell temperatureand the heat pipe operatesa chilling effect is revealed and the fuel cell which keeps the temperature of a fuel cell cell uniform by temperature control is provided.

[0015]

[Working example]Drawing 1 shows the exploded perspective view of the polymer electrolyte fuel cell 1 concerning one working example of this invention. Hereafterone working example of this invention is described using drawing 1. The fuel electrode film 3 and the oxidant electrode film 4 which combine the solid polyelectrolyte membrane 2and the conductivity allotted to both sides of said solid polyelectrolyte membrane 2 and breathability in this inventionIt has the separator 6 for oxidant gas which has the separator 5 for fuel gas and oxidant gas passage which have a fuel gas flow route for supplying gas to said electrode layeror discharging gas from an electrode layerThe heat pipe 8 which has the fin 11 for heat dissipation at the end is formed in the separator 5 for fuel gasand the separator 6 for oxidant gasand the fuel cell cell 7 is constituted by these.

[0016]In this casethe heat pipe 8 with the fin 11 for heat dissipation is connected to one [which makes a rectangle mostly] flank of the separator 6 for oxidant gas. ** arranged at the bottom -- the heat pipe 8 as the flank side of different another side with the same separator 6 for oxidant gas is formed in the separator 5 for fuel gas which makes a rectangle mostly. And two or more sheets of this fuel cell

cell 7 are laminateda layered product is constitutedand the polymer electrolyte fuel cell 1 is constituted.

[0017]The heat pipe 9 used by this invention may give surface coating by vacuum evaporation etc. to the metal plate surface with the precious metals excellent in corrosion resistance. A tube-like pipe is arranged in the metal plate which has conductivityand the hydraulic fluid 10 which is a heat transporting medium is enclosed in this pipe. The metaled thing excellent in the conductivity of aluminumstainless steelcopperetc. and processability is used for the metal plate which has conductivityand the things excellent in corrosion resistancesuch as goldsilvernickelan alumina alloyand titaniumare used for surface coating. The Reason conductivity is needed for the heat pipe 9 of this invention is for electrically connecting between two or more fuel cell cells 7 in series.[0018]The fin 11 for heat dissipation which processed the sheet metal is formed at the tip of the heat pipe 9and by attaching two or more theseit arranges so that heat transport can be performed easily. The waterammoniaacetoneand methanol system hydraulic fluid in which the hydraulic fluid 10 fitted the service temperature field of the fuel cell for conveying heat from a heat source by carrying out a phase change to a liquid from a gas from a liquid to a gas are used.

[0019]A cooling method of the heat pipe 9 is shown in drawing 2 (a) and (b). As for drawing 2 (a)drawing 2 (b) shows a cooling-shut-down state during a cooling operation. As a structure of the heat pipe 8in a metallic pipe of a tube which hits a radiator of the heat pipe 9it has a fixed pressure where a container of bellows 12 grade is inserted and which has the inactive gas 13such as air and nitrogen gasin itand is enclosed. When evaporating pressure of the hydraulic fluid 10 which is a heat transporting medium of the heat pipe 9 becomes higher than a container pressure of bellows 12 grade with a rise in heat of the fuel cell cell 7capacity which pushes up a container of bellows 12 grade and hits a radiator becomes large. It is cooled by the hydraulic fluid 10 used as a steam moving to this spaceand transmitting heat to the radiation fin 11hydraulic fluid is condensedand it becomes a liquidand returns to a lower heating region in

accordance with a wall of the heat pipe 9and a chilling effect is revealed.
[0020]Drawing 3 shows the solid polymer type fuel cell system 14 with which the fuel cell 1 concerning above-mentioned this invention was stored in the case of ******. As shown in this figurethe fin 11 for heat dissipation of the heat pipe 9 is enclosed by a ductforced cooling is carried out with the cooling fan etc. which were formed in the upper part of the ductand a chilling effect may be made to be acquired promptly. A figure Nakaya seal shows the flow of air. 21 is a fuel part.
[0021]On the other handsince the evaporating pressure of the hydraulic fluid 10 is lower than the gas pressure of the container of bellows 12 gradethere is no space which emits heat to the fin 11 for heat dissipation at the time of the cooling shut down of the heat pipe 9it accumulates heatand heats the fuel cell cell 7 promptly.
[0022]Thusthe temperature of the fuel cell cell 7 risesand in the case of the polymer electrolyte fuel cell 1 of this inventionwhen about 80 ** is reachedthe gas pressure of the container of bellows 12 grade can be adjusted so that the cooling may operateand temperature control of the fuel cell cell 7 can be performedfor example the time of reaching a certain temperature.
[0023]Although the heat pipe 9 used for this invention changes with calorific value of a fuel cellFor examplesupposing it performs temperature control of the fuel cell cell of the calorific value of 500W in the case of the polymer electrolyte fuel cell 1 of this inventionThe heat pipe 9 of a tube form 5 mm in diameter is arranged in the metal plate which has 5 conductivityand in the range 150 mm in lengththe fin for heat dissipation arranges a 10-mm-high thing at intervals of 3 mmand should just use it.
[0024]Nextthe operating method of the fuel cell cell in this invention is explained. By supplying the oxidant gas which uses hydrogen as main fuelsuch as fuel gasairor oxygenrespectivelythe fuel cell was made to generatecell temperature is in the same temperature as environmental temperature at the time of fuel cell startingand the cooling effect which is a function of the heat pipe 9 has stopped. Since the hydraulic fluid 10 serves as a steam of high temperature high

pressureit circulates through it inside the heat pipe 9 with the reaction fever which generates heat when reacting electrochemically at this time and that steam pressure is lower than the gas pressure of the container of bellows 12 gradeThere is no space which emits heat to the fin 11 for heat dissipationheat is accumulatedthe fuel cell cell 7 is heated promptlyand temperature is raised. If the temperature of the fuel cell cell 7 reaches beyond a room temperaturethe increase of activation of the catalyst in an electrode and cell reaction speed will increase. By the increase in this cell reaction speedsince the calorific value accompanying a reaction also increasesthe temperature of the fuel cell cell 7 also rises rapidly.

[0025]Thusthe temperature of the fuel cell cell 7 risesand the time of reaching a certain temperaturein the case of the polymer electrolyte fuel cell 1 of this inventionwhen about 80 ** is reachedthe cooling effect which is a function of the heat pipe 9 operatesfor example. Namelythe evaporating pressure of the hydraulic fluid 10 which is a heat transporting medium of the heat pipe 9It becomes higher than the container pressure of bellows 12 gradewhen about 80 ** is reachedThe capacity which pushes up the container of bellows 12 grade and hits a radiator becomes largeand the hydraulic fluid 10 cooled by the hydraulic fluid used as a steam moving to this spaceand transmitting heat to the radiation fin 11 is condensedand it becomes a liquidand returns to a lower heating region in accordance with the wall of the heat pipe 9. By making a chilling effect reveal by the circulation phenomenon of this hydraulic fluid 10temperature control of the fuel cell cell 7 is performed. Thusthe temperature of the fuel cell cell 7 under power generation can be kept constant by repeating the operation of the cooling effect of the heat pipe 9and a stop.

[0026]Although this example shows the example using the heat pipe 9 of the tube form in which the fin 11 for heat dissipation was formedthis invention is not limited to this but it should just have the function of the heat pipe 9 excellent in thermal transport property in the metal plate which has conductivity.

[0027]Thusby using the heat pipe 9 for the object for fuel gas to which it comes to

allot the fuel gas flow route and oxidant gas passage which are this inventionand the separators 5 and 6 for oxidant gasAs shown in drawing 5equipment of the pump 17 for cooling the fuel cell cell 7the cooling-circulating-water piping 18the cooling system 19 for exclusive useor a cooling method is unnecessaryThe pump power for circulating a cooling mediummanagement of the water which is a cooling medium furtheretc. are not neededbut the small size and the weight saving of equipmentand low cost-ization are attainedthe efficiency under power generation is raisedmaintenance control is easy and the fuel cell obtained inexpensive can be provided.

[0028]

[Effect of the Invention]According to this inventioncompared with the conventional fuel cellthe miniaturization of equipment and low cost-ization are attainedthe efficiency under power generation is raisedthere are also no necessitiessuch as maintenance control of cooling circulating waterand the fuel cell which attains shortening of the time which starting takes can be provided.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a block diagram showing the structure of the fuel cell cell by one working example of this invention.

[Drawing 2]It is an explanatory view showing the details of the heat pipe structure used for this invention and heatingand a cooling method.

[Drawing 3]It is a block diagram showing the fuel cell system using this invention.

[Drawing 4]It is a block diagram showing the structure of the conventional fuel cell cell.

[Drawing 5]It is a block diagram showing the composition of the conventional fuel cell system.

[Explanations of letters or numerals]

1 Polymer electrolyte fuel cell
2 Solid polyelectrolyte membrane
3 Fuel electrode film
4 Oxidant electrode film
5 The separator for fuel gas
6 The separator for oxidant gas
7 Fuel cell cell
8 Cold plate
9 Heat pipe
10 Hydraulic fluid
11 The fin for heat dissipation
12 Bellows
13 Inactive gas
14 Fuel cell system
15 Cooling fan
16 Duct
17 Pump
18 Cooling system
19 Cooling-circulating-water piping
20 Tank
21 Fuel part